

REMARKS

Claims 1-8 and 21-25 are pending in the application and stand rejected. Claims 1, 6, and 7 have been amended. Claims 4, 5, 9-20, and 22 have been canceled. Claims 26-33 have been added. No new matter has been introduced. Reconsideration and allowance of Claims 1-3, 6-8, 21, and 23-33 in view of the following remarks is respectfully requested.

Amendments to the Specification

The specification has been amended to conform to the guidelines for the preferred layout for the specification of a utility application. The relevant section headings have been amended to recite the "Summary of the Invention" and the "Detailed Description."

The Objections to Claim 4

The Examiner has objected to Claim 4 because of certain informalities. Claim 4 has been canceled rendering the objections moot.

The Rejection of Claims 4, 5, 6, 7, and 22 Under 35 U.S.C. § 112, Second Paragraph

The Examiner has rejected Claims 4-7 and 22 under 35 U.S.C. § 112, second paragraph, as being indefinite.

Claims 4 and 5

Claims 4 and 5 have been canceled rendering this ground of rejection moot.

Claims 6 and 22

It is the position of the Examiner that Claims 6 and 22 recite the identical limitation with different phrasing and therefore have equivalent scope. Claim 22 has been canceled rendering this ground of rejection moot.

Claim 7

It is the position of the Examiner that Claim 7 is indefinite because the scope intended by the phrase "chemically activated second nitriding gas" is unclear. Claim 7 has been amended to

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delete the allegedly indefinite phrase and to specify that the sputtering step is carried out in an atmosphere of N₂ gas, or a mixture of N₂ gas and an inert gas. Support for this amendment to Claim 7 can be found in the specification as filed at page 10, lines 1-3. Applicants submit that Claim 7, as amended, is definite and complies with 35 U.S.C. § 112, second paragraph. Withdrawal of the rejection is respectfully requested.

The Rejection of Claims 1-8 and 21-25 Under 35 U.S.C. § 112, First Paragraph

The Examiner has rejected Claims 1-8 and 21-25 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. It is the position of the Examiner that enablement for the step of "preparing an aluminum material containing CuAl₂" is deficient. While not acquiescing with the Examiner's position, but in order to facilitate prosecution, Claim 1 has been amended to delete the step of "preparing an aluminum material containing CuAl₂" and the step of plasma nitriding was amended to recite an "aluminum material comprising CuAl₂." Support for this amendment to Claim 1 can be found throughout the specification as filed, e.g. at page 2, line 31, to page 3 line 1; at page 4, lines 28 to 30; and at page 7, line 17. Applicants submit that Claim 1, as amended, and dependent Claims 2-8 and 21-25, comply with the enablement requirement. Withdrawal of the rejection is respectfully requested.

The Rejection of Claims 1-3, 6, 8, and 21-23 Under 35 U.S.C. § 102(b)

The Examiner has rejected Claims 1-3, 6, 8, and 21-23 Under 35 U.S.C. § 102(b) as anticipated by Tachikawa et al. (EP 0158271) ("Tachikawa"), considering Hirano et al. (U.S. 6,780,375) ("Hirano") and Yakabe et al. (U.S. 2008/0169049) ("Yakabe") as teaching references. Applicants note for the record that the Yakabe reference was published after the filing date of the present application and therefor is not properly citable as a prior art reference. It is the position of the Examiner that Tachikawa teaches an ion nitriding process that may be

applied to Al or Al alloys and includes a sputtering step. Applicants traverse the rejection for at least the reasons set forth below.

A rejection under 35 U.S.C. § 102(b) requires that all the elements of a claim be found in a single reference. See, e.g., *In re Donahue*, 766 F.2d 531, 534 (Fed.Cir. 1985).

Claim 1, as amended, is directed to a process of producing an aluminum material having an aluminum nitride (AlN) region on the surface thereof, comprising the step of: plasma nitriding an aluminum material comprising CuAl_2 , wherein the plasma nitriding step comprises applying to an atmosphere of a nitriding gas selected from the group consisting of NH_3 , a mixture of N_2 and H_2 , a mixture of NH_3 and an inert gas, and a mixture of N_2 , H_2 , and an inert gas, a pulse voltage of -50 V to -50 kV for a period of from 0.1 μs to 10 ms; suspending the application of the voltage for a period of from 0.1 μs to 100 ms; and repeatedly applying the pulse voltage and suspending the application of the voltage to thereby form an AlN region on the surface of the aluminum material. Support for the amendment to Claim 1 can be found in the specification at page 10, lines 10 to 20; and original Claim 4. Claims 2, 3, 6, 8, and 21-23 depend from Claim 1.

The Tachikawa reference teaches an ion nitriding process in which a glow discharge is generated using direct or alternating current. See page 5, line 30. In the nitriding process described in Tachikawa, the discharge is continuous. See, e.g., page 6, lines 12-13 ("the discharge was continued further for 2 hours"); see also page 6, line 23 ("[a]fter the nitriding treatment, the discharge was ceased"). The Tachikawa reference provides no teaching that, during the nitriding process, the voltage is applied for a period of from 0.1 μs to 10 ms; then application of the voltage is suspended for a period of from 0.1 μs to 100 ms; and this cycle of applying and suspending the application of the voltage is repeatedly performed, as claimed.

Accordingly, since the Tachikawa reference does not teach all the elements of amended Claim 1, the Tachikawa reference does not anticipate Claim 1, as amended, and also does not

anticipate dependent Claims 2, 3, 6, 8, and 21-23. Withdrawal of the rejection is respectfully requested.

Claim 1, as amended, is also not obvious over the Tachikawa reference for at least the reasons set forth below in regard to Claims 4 and 5, the limitations of which have been incorporated into amended Claim 1.

The Rejection of Claims 4, 5, 7, 24, and 25 Under 35 U.S.C. § 103(a)

Claims 4 and 5

The Examiner has rejected Claims 4 and 5 under 35 U.S.C. § 103(a) as being unpatentable over Tachikawa, considering Hirano and Yakabe as teaching references. It is the position of the Examiner that, although the Tachikawa reference does not specify any particular voltage values or ranges or time parameters, that one skilled in the art would be able to optimize parameters through routine experimentation. Applicants traverse the rejection for at least the reasons, as set forth below, that Tachikawa does not recognize the time parameters as a critical variable; Tachikawa teaches away from the claimed process; and the claimed process has achieved improved and unexpected results.

Obviousness is determined by analyzing the factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). The inquiry under *Graham* includes ascertaining the differences between the prior art and the claims at issue.

The differences between Tachikawa and Claim 1

As discussed supra, the Tachikawa reference teaches an ion nitriding process in which a glow discharge is generated using direct or alternating current, and the discharge is continuously applied. In contrast, in the claimed method, during the nitriding step, the voltage is applied as a short pulse (less than 10 ms); the application of the voltage is then suspended for a period of less than 100 ms; and this cycle of applying and suspending the application of the voltage is

repeatedly performed. As the Examiner acknowledges, the Tachikawa reference does not remotely teach or suggest the voltage and time parameters of the claimed method.

The Tachikawa reference teaches away from the claimed method

Under M.P.E.P. § 2141.02, the teachings of a reference must be considered as a whole, including any disclosure that teaches away from the claimed invention. As discussed supra, the Tachikawa reference teaches a nitriding process in which the current is continuously applied. The Tachikawa reference does not provide any teaching or suggestion that the voltage can be applied in short pulses, as claimed. Accordingly, the Tachikawa reference teaches away from the claimed process.

The Tachikawa reference does not recognize the voltage and time parameters as critical

It is established case law that obviousness does not arise when the prior art gives "either no indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful." *In re Kubin*, 2009 U.S. App. Lexis 6914 (Fed. Cir. 2009). Furthermore, under the M.P.E.P. § 2144.50(II)(B), a particular parameter must first be recognized as a result-effective variable, i.e. a variable which achieves a recognized result, before the determination of the optimum ranges of said variable might be characterized as routine experimentation (emphasis added).

The Tachikawa reference does not provide any suggestion that the voltage or time parameters are critical. The Tachikawa reference merely states that a "direct current voltage of several hundred volts was applied across the two electrodes." The Tachikawa reference provides no suggestion that applying the voltage in short pulses would affect the results and therefore does not recognize the time parameter as a result-effective variable. Accordingly, applicants' discovery of a process of producing aluminum having an aluminum nitride region on the surface,

in which a pulse voltage is repeatedly applied and suspended, resulting in an improved product, as discussed below, is not a result of routine experimentation.

The claimed process achieves improved and unexpected results

Non-obviousness can be shown by providing evidence that the claimed invention yields unexpectedly improved properties or properties not present in the prior art. See M.P.E.P. § 2145. Applicants have surprisingly found that the claimed plasma nitriding process of applying a voltage in short millisecond pulses, followed by suspending the application for a period of time in milliseconds, and repeatedly performing the pulsing and suspension cycle, yields an improved aluminum product in which the aluminum nitride on the surface is uniform, has high adhesion to the base material, and is thicker than the aluminum nitride layer produced by the process described in the Tachikawa reference. For example, Table 1 on page 6 of the Tachikawa reference shows that after 4 hours of nitriding treatment, the aluminum nitride layer had a thickness of only 1.8 μm , whereas 4 hours of treatment according to the claimed process produced an aluminum nitride method of 40 μm (see specification, page 15, lines 16-18). Similar results were obtained after treatment of 6 hours (Tachikawa process: 3 μm ; claimed process: 80 μm). Nothing in the prior art of record even remotely addresses the unexpected results obtained by the claimed invention.

For the reasons discussed above, i.e., the Tachikawa reference (i) does not teach all the elements of the claimed process; (ii) actually teaches away from the claimed process; and (iii) does not recognize that the time parameter is a result-critical variable; and, furthermore, the claimed process achieves improved results; Claims 4 and 5 are not obvious over the Tachikawa reference. Accordingly, amended Claim 1 is also not obvious over the Tachikawa reference. Withdrawal of the rejection is respectfully requested.

Claims 7, 24, and 25

Claims 7, 24, and 25 depend from Claim 1. For the reasons discussed above, Claim 1 is not obvious over the Tachikawa reference and, accordingly, Claims 7, 24, and 25 are also not obvious over the Tachikawa reference. Withdrawal of the rejection is respectfully requested.

The Rejection of Claims 4, 5, and 7 Under 35 U.S.C. § 103(a)

The Examiner has alternatively rejected Claims 4, 5, and 7 under 35 U.S.C. § 103(a) as being unpatentable over Tachikawa, considering Hirano and Yakabe as teaching references, and further in view of Tachikawa et al. (U.S. 4,909,862) (the "'862 patent"). It is the position of the Examiner that the '862 patent teaches a preparation stage of cleaning organics and aluminum oxide from the surface of the aluminum before the nitriding process by employing a chemically reactive gas such as nitrogen in combination with an inert gas. Applicants traverse the rejection for at least the reasons set forth below.

For the reasons discussed supra, Claims 4 and 5 (incorporated into amended Claim 1) and Claim 7 are not obvious over the Tachikawa reference. The teachings of the '862 reference do not cure the deficiencies of the teachings of the Tachikawa reference. The '862 reference does not remotely teach or suggest a nitriding process in which a pulse voltage of -50 V to -50 kV is applied for a period of from 0.1 μ s to 10 ms; application of the voltage is suspended for a period of from 0.1 μ s to 100 ms; and the cycle of applying the pulse voltage and suspending the application of the voltage is performed repeatedly.

Accordingly, amended Claim 1, and dependent Claim 7 are not obvious over the Tachikawa reference in view of the '862 patent. Withdrawal of the rejection is respectfully requested.

New Claims 26-33

Claims 26-33 have been added. Support can be found in the specification at page 10, lines 1-3 and 10-20; and in originally filed Claims 2, 4, 8, 21, and 23-25. As discussed supra, Claim 1 recites a plasma nitriding step and Claim 7 recites a sputtering step. Claim 26 is a combination of Claims 1 and 7, and recites both a plasma nitriding step and a sputtering step.

Claim 26 is directed to a process of producing an aluminum material having an aluminum nitride (AlN) region on the surface thereof, comprising the steps of (a) sputtering an aluminum material comprising CuAl_2 to remove Al_2O_3 present on the surface of the aluminum material, wherein the sputtering step is carried out using the aluminum material as the negative electrode by applying a D.C. voltage of -50 V to -4000 V to an atmosphere of N_2 gas, or a mixture of N_2 gas and an inert gas; and (b) plasma nitriding the aluminum material prepared as in step (a), wherein the plasma nitriding step comprises applying to an atmosphere of a nitriding gas selected from the group consisting of NH_3 , a mixture of N_2 and H_2 , a mixture of NH_3 and an inert gas, and a mixture of N_2 , H_2 , and an inert gas, a pulse voltage of -50 V to -50 kV for a period of from 0.1 μs to 10 ms; suspending the application of the voltage for a period of from 0.1 μs to 100 ms; and repeatedly applying the pulse voltage and suspending the application of the voltage to thereby form an AlN region on the surface of the aluminum material. Claims 27-33 depend from Claim 26.

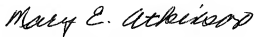
For the reasons discussed supra as relates to Claim 1, Claim 1 is not obvious over the Tachikawa reference, or over the Tachikawa reference in view of the '862 patent. Claim 26 includes all the limitations of Claim 1. Accordingly, Claim 26, and dependent Claims 27-33 are not obvious over the Tachikawa reference, or over the Tachikawa reference in view of the '862 patent, and are allowable.

CONCLUSION

Applicants believe that Claims 1-3, 6-8, 21, and 23-33 are in condition for allowance. Reconsideration and favorable action is requested. If any issues remain that may be expeditiously addressed in a telephone interview, the Examiner is encouraged to telephone applicants' attorney at 206.695.1795.

Respectfully submitted,

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